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Dormant Branches

The Council of the Institute of British Foundrymen is somewhat concerned about the inequality of effort made by the Branches. The actual position is that all the Sections and every Branch except two are extremely active. Of the two exceptions one has its organisation well established and is in a position to function at a week's notice. The second, that of Newcastle, at one time the largest Branch of the Institute, is quite dormant and requires complete reorganisation. The matter is being energetically taken up by headquarters, and the acting secretary, Mr. John Bolton, would welcome suggestions from the area. Just as in times of crisis, foundry owners feel the need for local co-operative effort, so too might the technicians. It is truthful to state that the Institute ranks high in the activity list of technical associations; it is now operating at 75 per cent. of its very high pre-war standard. To maintain interest, departures have been made from the stereotyped procedure with excellent results. There is a realisation that such features as the examination and discussion of specimen castings and the holding of a Brains Trust make no permanent contribution to or enrichment of technical literature, but they do afford an excellent means of directing existing knowledge to the solution of current problems. This type of meeting, seasoned as it is with the spice of novelty, attracts large audiences of high-grade technicians interspersed with keen youngsters, and thereby affords informal opportunities for solving problems not necessarily scheduled for discussion.

If the recent extremely successful Brains Trust held in London had borne the label "Question Night," the same ground would have been covered, but with a skeleton audience in attendance. The outstanding advantage of the new system is the initial assurance, due to the eminence of the members of the panel in the metallurgical and foundry fields, that any advice given or opinion offered is authoritative. Even where differences of opinion exist, as must necessarily be the case with some subjects, pointers are given capable of practical application, or reinforcing technical appreciation of the problems to be solved. The opinion was expressed that a Brains Trust had no place in scientific circles, it being postulated that the spontaneous answering of questions would result in evasions, misleading answers and general inadequacy. We believe this to be true, if questions of too specialised a character are permitted, but a choice limited to those of general interest only, ensures reasonable enlightenment from diverse angles.

Another very successful meeting of the session was one addressed by Mr. Ronald Webster, of Chicago, on the novel subject of the cleaning of castings by a mixture of sand and water sprayed on their surfaces at high pressure. Here there was the twofold interest of hearing an overseas speaker dealing with a new development in practice. From the above, it is apparent that larger audiences can be attracted in wartime and interest in the Institute's affairs well maintained provided some novel angle can be presented. Despite what we have written, we still insist that where Branches can maintain the level of pre-war attendance and interest by the creation of a programme of the type of which long experience has sanctioned as being of lasting benefit, then they are performing the best service to the Institute and the industry for which it caters. There is every reason for the Institute to be proud of its wartime record, not only in the field of its lecture programmes, but also because of its practical co-operation with the authorities for the expansion of the steelfounding industry and in other similar directions. The appearance of but one enthusiastic organiser in the "dormant" areas would ensure it the leading position in the field of technical service to industry during wartime.

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METAL PRICES IN WARTIME

By "ONLOOKER"

While the governments in both Britain and the United States are wedded to the policy of opposing inflation and have afforded proof of their determination to resist any upward movement in prices by fixing upper limits for the principal commodities, there is nevertheless a section of opinion which says that the last ounce of production can only be secured by means of monetary rewards. Possibly that is why the U.S. Government has decided to grant a bonus of 5 cents on all copper produced during 1942 in excess of the 1941 total, similar concessions for zinc and lead being at the rate of 2.75 cents per lb. and 3.40 cents. Actually since this arrangement was concluded the current price of lead has advanced to 6.50 cents, so that the value of the bonus addition is reduced by 65 points, but even so it should be a real inducement to the producers to go ahead on production. Copper at 12 cents is sufficiently priced to encourage output from a good many mines, and the quotation from the producer's point of view, compares favourably with what was ruling in the years before the war. For example, the average for 1940 was but little more than 11¼ cents, and in 1939 it was below 11 cents. In 1937, a year likely to be remembered for the strong upward price movement during the early months, the average worked out at over 13 cents., but in 1938 it was 10 cents and in 1936 just under 9½ cents.

In the same way the price of lead, which to-day is 6.50 cents per lb., makes a much better showing for the producer than in the immediate pre-war years. The average for 1937 was, it is true, just over 6 cents, but in both 1936 and 1938 it was around 4.7 cents, and in 1935 just over 4 cents. Spelter in now priced at 8.25 cents per lb. in the U.S.A., having been advanced by 1 cent a few months ago, but before the war this metal, with the exception of the year 1937, ruled for the most part below 5 cents.

A moment's thought on these changing price levels would appear to give a sufficient answer to those who feel that higher prices are necessary if production is to reach its utmost limits, for it would certainly seem that American producers cannot secure an adequate return on everything they turn out. In the same way producers operating in the sterling field see, when they review the years just prior to the war, that with the notable exception of 1937 the average values of copper, lead, zinc, and for that matter of tin too, were quite a lot below what they are to-day. At the same time consumers cannot complain that in the light of existing world conditions price levels are unduly high; they certainly are not, and if free markets had been ruling it is hard to say what would have been the top. Let us not forget that in 1920 tin climbed to within a few shillings of £420 and that spelter stood at £115 in 1915, but during the present world crisis Government intervention has made it possible to keep metal prices down at a level which would have been impossible in the circumstances obtaining during the years 1914/18.

SHORT REVIEWS

The Projected Grand Contour Canal. By J. F. Pownall. Published by Cotterell & Company, 110, Dale End, Birmingham, 4. Price 2s.

The basis of this interesting little book is the utilisation of the approximate 310-ft. level, which seems a naturally favourable altitude for the construction of two canals, one from London to Manchester and Newcastle and the other from London to Bristol.

Classification of Copper and Copper Alloys. Issued by the Copper Development Association, Grand Buildings, Trafalgar Square, London, W.C.2.

A real service to industry has been done by this publication, because unlike the case of the light alloys and several other groups, an up-to-date statement of the composition and properties of copper alloys was not available. The materials listed are truly representative, and their classification has been very intelligently compiled. It is available to our readers on application to the Association.

Machining of Metals. Research Bulletin No. 6. Published by the Sheffield City Libraries. Price 3d. (postage cost).

It has been authoritatively stated that mechanical engineering is badly served from a bibliographic point, and the issue of this Bulletin should go far to eliminate this defect so far as this specialised branch of machining is concerned. From a purely foundry point of view there is some ground for criticism, as apparently the Proceedings of the Institute of British Foundrymen have not been searched. One of its original Papers is credited to a secondary source. The size of the subject can be well envisaged, as the references require 45 pages for their detailing. The Bulletin will be sent free of charge to research departments, large works and the like, on the prepayment of the requisite threepenny postage.

CORRESPONDENCE

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

"In Smaller Mould."

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I feel I must write and compliment you on your very splendid effort in giving us the JOURNAL in what you describe as "In Smaller Mould." Your idea of giving it in this form rather than limiting the number of copies is, I think, a very wise one, as I think foundrymen need the JOURNAL more now than at any other time. One would like at times like these to introduce prospective readers to you, but I understand from friends that they have been unable to get copies from their newsagent. Anyhow, I wish you all success in your effort to keep the JOURNAL going in these difficult days.—Yours, etc.,

E. J. KELLY.

Pontypridd.
May 5, 1942.

CUPOLA-MELTED HIGH-DUTY CAST IRONS*

Practical Experience of a New Departure in Cupola Practice in Making High-Strength Irons

By W. W. BRAIDWOOD

The advent in 1938 of B.S. Specification No. 786 heralded a new era in iron-foundry practice. From that year, no progressive firm could afford to lack the means of producing castings to satisfy the most exacting of the new requirements. Then, as now, two well-established patented processes were available to interested concerns. By the utilisation of either, it is claimed, high strength irons may readily be produced from the cupola. Details of these protected processes are, naturally, disclosed only to licensees, but it may safely be stated that they have in common two essential features:—(1) Incorporation in the cupola charge of appreciable proportions of steel scrap, and (2) spout or ladle addition of graphitising agents.

In the foundry with which the writer is connected, it was decided to proceed with the development rather than the adoption, of a satisfactory technique. Good quality cast irons, with tensile strengths of the order of 18 tons per sq. in., were, and still are, constantly being produced in considerable volume and by very economical means, the cupola charges consisting essentially of chill-cast, 3 per cent. silicon pig-iron and steel scrap. It seemed logical to expect that modification of this procedure, with the aim of eventual elimination of the high-carbon, graphite-bearing constituents of the cupola charge, should result in improvement in the physical properties of the irons produced. In short, it was hoped ultimately to employ all-steel charges, supplying the necessary silicon and manganese by ferro-alloy rather than pig-iron additions.

Cupola charges of this type were expected to yield final carbon contents within the range of 2.5 to 3.0 per cent. This feature of composition would provide satisfactorily low percentages of graphitic carbon in the resultant grey iron structures, would permit the use for castings of normal section of silicon contents in excess of 2 per cent., and would, as reported by MacDougall,[1] render variation in silicon content above that figure less able acutely to influence the structure and properties of the irons produced.

* A Paper read before several Branches of the Institute of British Foundrymen.

Summary of Experimental Results

The initial experimental melts were carried out on the lines indicated, and the results were immediately encouraging, tensile strengths in excess of 20 tons per sq. in. being obtained on the 1.2 in. dia. bar. A careful record was kept of all circumstances, and results and much useful information accrued. While it is not proposed to describe this exploratory work in detail, the main findings may be quoted as follows:—

(1) The procedure was successful in its object of producing cast irons satisfying the highest requirements of B.S. Specification No. 786.

(2) The material cost of high strength iron produced in the manner outlined was actually lower than that of ordinary cast iron produced from charges of the orthodox type.

(3) Conventional ideas with regard to coke: metal ratios do not apply to the melting of high-steel charges. It must constantly be remembered that a really considerable proportion of the total weight of coke charged is utilised, not as fuel, but as the provider of carbon absorbed by the melt.

(4) The physical condition of the scrap steel used in such cupola charges is a most potent factor. Wherever possible the scrap employed should be of standard type since variation in its form is liable to cause considerable variation in the results obtained. As the ratio of surface area to mass is decreased, that is, as the section thickness of the scrap is increased, oxidation losses on cupola melting tend to be reduced. Massive scrap, however, is unsatisfactory since it melts sluggishly, and the ideal type of steel scrap for cupola melting is probably that which is moderately heavy in section and of hollow form. The writer is fortunate in having at his disposal adequate supplies of scrap of this description, with an average surface/mass ratio of approximately 10 sq. in. per lb. Typical examples are illustrated in Fig. 1.

Test Procedure

Actual production of high-strength iron castings was then begun under carefully controlled conditions, the aim being to combine profit-making

Cupola-Melted High-Duty Cast Irons

operations with informative practical research. Before commencing the report of this work it is probably advisable to provide a precise description of the test procedure so that the results soon to be quoted may be capable of absolute interpretation.

All test-bars were poured from the ladle containing the whole bulk of the tap studied, and never from metal caught at the cupola spout. All analyses, micro-examinations, and physical tests were conducted on 1.2 in. dia. bars, poured, and allowed to cool, within standard oil-sand moulds of the design illustrated in Fig. 2; and all of the results quoted relate to bars tested in the "as-cast" condition.

The bars were first broken in transverse on 18-in. centres and determinations made of transverse

FIG. 1.—TYPICAL EXAMPLES OF CASTINGS.

rupture stress and deflection; but, since the bars were unmachined at that stage, and were, therefore, never of truly circular cross-section, the figures obtained are not reproduced. It should be made clear, however, that they were consistently and considerably in excess of the requirements for High Duty Iron, Grade 3.

All other tests were carried out on specimens machined from portions of the fractured bar. The tensile test-pieces, 0.798 in. dia. on the gauge length, were provided with threaded ends which, during test, were located within self-aligning grips. Hardness was expressed as the average of three determinations in close agreement, conducted on the cross-section of the 1.2 in. dia. bar. The indentations were equally spaced around the circumference of a circle, concentric with the contour of the bar, but of half its diameter, and use was made of the standard Brinell machine, with the 10-mm. ball and 3,000-kg. load.

Single-blow impact tests were conducted in accordance with the recommendations of the British Cast Iron Research Association, on unnotched bars, 0.798 in. dia., broken in a standard 120 ft.-lb. Izod machine fitted with a modified vice. This is designed to hold the round specimen and to give a striking height of 1.3 in. (The gaps, which will be observed to occur under the heading "Impact," are due to the fact that this test procedure was established only when the investigation was well advanced, and several of the retained specimens were found to have an insufficient length of unused bar remaining.)

In every case, the specimen submitted for microscopical examination, and the drillings supplied for analysis were obtained from positions approxi-

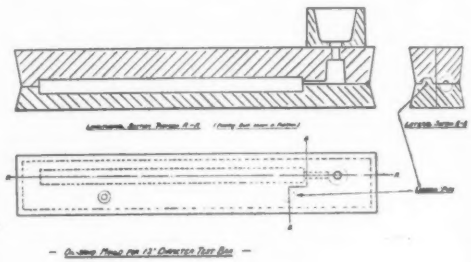


FIG. 2.—OIL-SAND MOULD FOR 1.2-IN. DIA. TEST-BAR.

mately midway along the length of the bar. All of the reported determinations were made by a very competent staff under purely research conditions, and duplicate tests were conducted, wherever confirmation seemed desirable.

Recording Details

Full details of all conditions and results were carefully tabulated in a form providing ease of reference and comparison, and the following were listed as subjects deserving of particular study:—

(1) The influence of variations in coke quantities: (*a*) The height of the charged bed; (*b*) the weight of the unit charge; and (*c*) the depth of subsequent and/or separating layers.

(2) Determination of the most efficient and economical means of making the required additions of silicon, manganese, etc.

(3) The influence upon the structure and properties of the resultant irons exerted by: (*a*) In-

corporation of proportions of returned scrap in the cupola charge; (*b*) spout or ladle additions of graphitising agents; and (*c*) the presence of alloying elements, singly and in combination, and in various concentrations.

For this programme of production and practical research use was made of a 32-in. dia. cupola of orthodox design; indeed, just that type of cupola likely to be found in almost any iron-foundry. A sketch of this furnace will be presented later, and at this juncture it will be sufficient to state that it is fan-blown at a maximum pressure of 21 in. water-gauge, the air entering through a single row

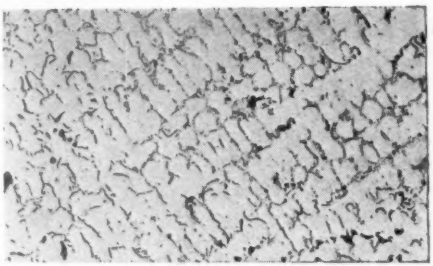


FIG. 3.—TEST-BAR FROM MELT NO. 9. PHYSICAL TEST RESULTS: HARDNESS, 264 BRINELL; TENSILE, 23.84 TONS PER SQ. IN.; IMPACT, 11 FT.-LBS. UNETCHED × 50 DIA.

of four tuyeres, each of rectangular cross-section and measuring 5 in. long by 4 in. deep.

This unit is in everyday use melting low-silicon irons for the production of white-iron castings. The charges employed, which consist of hematite pig, steel scrap and returned white-iron scrap, are, fortunately, very suitable for melting in association with high-steel charges for high-duty irons.

Cupola Practice

For the initial melts the bed was made up to a level 48 in. above the tuyeres, and very satisfactory results were obtained. Subsequently, this height was reduced in stages to 36 in. with no measurable alteration in the temperature, composition or properties of the tapped metal. Further lowering of the bed height, however, was found to be accompanied by some reduction in temperature. The height of the charged coke bed was thereupon standardised at 36 in., and this is carefully maintained in all instances by dip rod control.

The maintenance of normal conditions throughout a lengthy melt of high-steel charges can be a matter of some difficulty. Simultaneously with the progress of such melts there tends to occur a progressive lowering of the carbon, silicon, and manganese contents of the tap. The proneness of the ferro-alloys, etc., to melt prior to the accompanying steel scrap contributes to, but is not the chief cause of this condition, and it is undeniably the case that, unless preventive measures are adopted, melting conditions, with charges of this type, become progressively more oxidising as the melt proceeds.

Field,[2] Hudson,[3] Russell[4] and Mackenzie[5] have each demonstrated convincingly that, in the cupola, steel scrap is not carburised to any appreciable extent until it is actually molten. That is to say, such scrap melts as steel and not as highly-carburised metal of much lower melting point. That being so, and since the melting point temperatures of mild steel and of normal cast iron are approximately 1,500 and 1,150 deg. C., respectively, steel scrap in the cupola must melt at a level considerably nearer to the zone of maximum temperature than does cast iron. Therefore, when steel is melted, a relatively shallow bed of incandescent coke is available for superheating. Moreover, since carburisation takes place almost entirely after the steel has become molten, the carbon absorbed, which is of considerable amount, is derived wholly from that shallow layer of burning coke. This, in turn, causes further reduction in the actual bed height, and the observed increase in oxidation, the lowered carbon content and the eventual fall in temperature normally accompanying progress of melting of all-steel charges, become logical expectations.

An essential factor, therefore, of constancy of the conditions of melting is continued adequacy of the depth of that vital coke layer. Two alternative methods of ensuring such maintenance come readily to mind:—(1) The employment of really generous unit coke charges, and (2) the provision of extra coke, in the form of separating or "sandwich" charges, as required.

Heavy Coke or Sandwich Charges?

To test the possibilities of the former method, experiments were made in the use of more and more generous unit coke charges, but, even when the "charged fuel:metals" ratio was raised to 1:6½, the observed tendency to produce progressively harder iron, though markedly reduced, was not eliminated.

Experiments subsequently made on the basis of the second alternative have shown this to be a

complete success. The coke "sandwiches" are inserted at the intervals indicated as the limits of the individual taps—generally these are of 30 cwt. each—and the greater certainty of proper location of the charged alloys which their presence promotes, is an additional advantage. They therefore assist greatly in ensuring uniformity or sharp difference in the composition of successive taps, as desired. Their presence, moreover, makes possible the restriction of unit coke charges to very scanty proportions without ill effect. Full details of all the circumstances of an actual melt will be quoted later in this Paper, in order to provide concrete recommendations with regard to coke distribution.

At the outset the necessary silicon, manganese and chromium additions were made exclusively in the form of charged briquettes. These consist of ferro-alloys crushed to within certain limits of size, bonded with cement and moulded in distinctive shapes. They are undoubtedly a very convenient form of addition, and the specifications made with regard to their respective alloy contents were confirmed by analysis. It is claimed that, owing to the protective action of the binder, oxidation of the alloying material is minimised. When, however, the melting losses for silicon and manganese were found to average approximately 20 and 30 per cent. respectively, it was decided to experiment with alternative materials.

Unprotected ferro-alloys were charged, and the results from the subsequent melts showed that lump ferro-silicon is actually a more efficient alloying medium than the briquetted material. The explanation may lie in the fact that the particles of ferro-silicon incorporated in the briquettes, being very much smaller than the alternative fist-sized pieces, eventually expose to oxidising influences a much greater area of surface per unit of mass. Two further materials, 15 per cent. silicon pig-iron, and lump calcium silicide, were available in small amounts and the opportunity was taken to test their possibilities. The complete list of fairly comparable test results is set out in Table I.

It is demonstrated that:—

(1) Each of the materials tested is capable of successful use in the production of high-tensile irons.

(2) From the point of view of silicon recovery, unprotected ferro-silicon is the most efficient of all. Indeed, when cost is considered, the charging of lump ferro-silicon is shown to be by far the most advantageous method of adding silicon in the cupola. (Note.—Figures of cost are quoted for purposes of comparison only, and are calculated from the market prices ruling at August 31, 1939.)

(3) Micro-examination showed the matrix of each of the specimens to consist of pearlite, resolved, in all instances, at a magnification of 250 diameters. The size and arrangement of the graphite, however, was seen to vary widely, ranging from extremely fine, interlacing deposits, distributed in a network around the grain boundaries, to relatively coarse flakes presenting no definite patterns whatsoever.

(4) This wide variation in graphite size and arrangement appears to exert no dominating influence upon the tensile strengths of the irons concerned, but resistance to impact is markedly affected. It is evident that this property is inversely proportional to regularity of the graphite pattern; that is to say, the more haphazard the distribution of the graphite flakes, the greater the resistance to impact possessed by the whole mass—all other factors being equal.

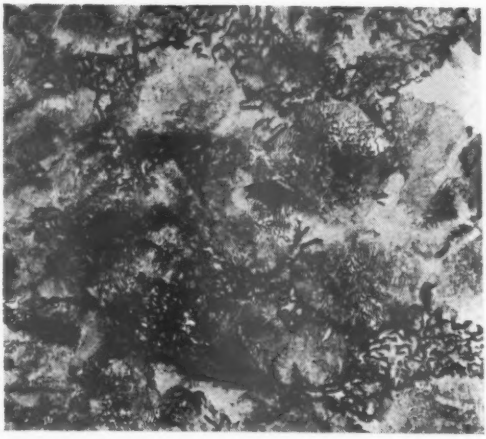


FIG. 4.—TEST-BAR FROM MELT NO. 9. ETCHED (3 PER CENT. NITAL) × 250 DIA.

The last relationship may readily be traced by reference to Table I, and photo-micrographs of the structures of three of the cast irons featured therein have been chosen to illustrate the variations in graphite form occurring in irons of otherwise similar type.

Cupola-Melted High-Duty Cast Irons

Form of Graphite

The unetched structure of the bar poured from melt No. 9, at a magnification of 50 diameters, is shown in Fig. 3. The graphite is present entirely in the form of very small flakes outlining the boundaries of what were originally the crystals of austenite formed in the earlier stages of the process of solidification. Graphite of this type has been variously referred to as "supercooled," "dendritic," "abnormal," "eutectic" and "eutectiform." Not

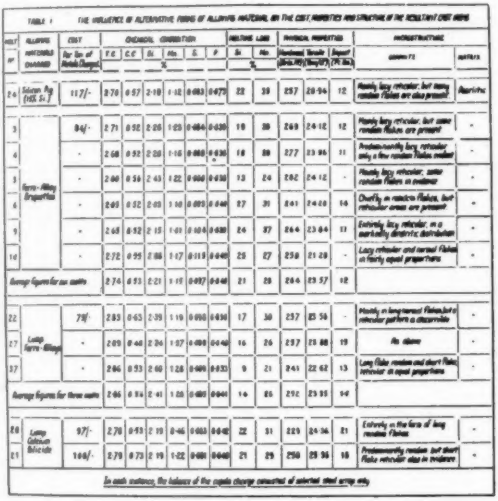


TABLE 1.—*Influence of Alternative Forms of Alloying Material on the Cost, Properties and Structure of the Resultant Cast Irons.*

one of these terms is strictly correct, and some are actually misleading. Recently the term "grain-boundary graphite" has been introduced, and this is undoubtedly the most accurate description so far applied. Indeed, its only shortcoming is its length, which is sufficient to be cumbrous. To describe graphite of this type the present writer prefers to use the term "reticular," which is defined as:—"Having the form of network," "formed with interstices," "resembling a net," and, even at the risk of monotony, this description will be applied throughout the present Paper.

The etched structure of the same specimen at a magnification of 250 diameters is shown in Fig. 4. The matrix is seen to consist of finely divided pearlite. At this higher magnification the individual graphite flakes are seen to be present as a multitude of tiny interlacing flakes framing the grain boundaries. This particular mode of occurrence will be termed "lacy, reticular" graphite, throughout. The drastically weakening effect which such an inter-granular concentration of graphite will produce can readily be imagined, and it is no surprise to find that the presence of lacy, reticular graphite is always associated with low resistance to impact. (*To be continued.*)

SUBSTITUTE DEOXIDISERS

The commercial production of calcium metal in the United States is a metallurgical development of interest to users of alloying elements both in ferrous and non-ferrous fields. American consumers of calcium formerly depended on importations, particularly from France and Germany. Calcium metal is used as a grain refiner in magnesium, a deoxidiser in electrical copper, a dispersion stabiliser in high-leaded bronze, a hardener in lead, and a scavenger in steel and various non-ferrous metals and alloys. Many potential uses of calcium metal in these and other applications are being further developed. Because of the shortage of aluminium for deoxidising purposes in steel production, the use of other deoxidising metals has increased. These include such scavengers as "Silcaz" alloy 3, calcium-manganese-silicon, and silicon-zirconium alloys. "SMZ" alloy is used in cast iron because of its graphitising action and beneficial effect on the physical properties. Used with S.M. ferro-chrome (of the Electro Metallurgical Company), it can practically duplicate the chill characteristics of copper and nickel, and, in many cases, replace these elements. "CMSZ" alloy can, in many cases, be used to similar advantage, states W. D. WILKINSON in "Blast Furnace and Steel Plant."

Anthracite as a Foundry Fuel was widely used in the United States between 1840 and 1875. The Hudson Coal Company, to revive this practice, has been conducting tests for 18 months to prove that such use would be effective and economical. During this time approximately 125 tons of egg coal have been utilised to produce about 835 tons of metal for conveyor plates, grates and grate bars, cast-iron pipes, locomotive brake shoes, drum pulleys, bedplates, pump parts and other metal parts for the company's operation. Results were so successful that all the company's castings are now made with anthracite as the fuel medium.

Blast-Furnace Relining Record.—The Columbia Steel Company, subsidiary of United States Steel Corporation, claims a new world record for speed in relining a blast furnace, *viz.*, 31 days for the complete job, which is some 20 days off previous records by eastern plants. Some previous American and Empire records were referred to in our issue for January 8 last.

INSTITUTE OF BRITISH FOUNDRYMEN

Annual General Meeting

The annual general meeting of the Institute of British Foundrymen will be held at the Waldorf Hotel, London, W.C.2, on Saturday, June 20 next, commencing at 10.30 a.m. The proceedings will start with the induction of officers and the awards of medals, and will be followed by the presentation of the Edward Williams' Lecture on "Foundry Teamwork," by Dr. H. W. Gillett (Chief Technical Adviser, Batelle Memorial Institute, Columbus, Ohio, U.S.A.). The lecture will be presented in full on behalf of Dr. Gillett by Dr. C. H. Desch, D.Sc., Ph.D., F.R.S., F.I.C.

Luncheon has been arranged for 1 p.m. (tickets, price 8s. 6d., on application).

The afternoon meeting will commence at 2.30 p.m., when the following Papers will be presented and discussed:—

Session A.—No. 749, "The Production of Uniform Steel for a Light Castings Foundry," by C. H. Kain (Member) and L. W. Sanders (Associate Member); No. 750, "Pearlitic Malleable Cast Iron," by Carl F. Joseph (American Foundrymen's Association Exchange Paper); No. 751, "The Substituting of High-Duty Grey Iron for Steel Castings," by J. Blakiston (Member).

Sessions B.—Non-ferrous Papers, of which details will be published in due course.

Members are advised to make early application for hotel accommodation if this is desired. If booking at the Waldorf Hotel, attendance at the Institute of British Foundrymen's annual general meeting should be stated, as special terms will be available to members.

Meetings of committees and the Council will be held at the Waldorf Hotel on Friday evening, June 19. These meetings are open only to Council and committee members, who will be advised of further details in due course.

E. J. Fox 1942 Medal Award

The Council of the Institute of British Foundrymen has accepted the recommendation of the Assessors (Sir William Larke, K.B.E., and Dr. J. E. Hurst, J.P.) that the 1942 award of the E. J. Fox Gold Medal be made to Mr. P. H. Wilson, assistant managing director (technical) of the Stanton Ironworks Company, Limited, Nottingham. The award is made in recognition of Mr. Wilson's work in the development of the centrifugal castings process for the production of cast-iron pipes. The technical development of this process, from the very beginning of its installation at Stanton, was the care and responsibility of Mr. P. H. Wilson, and in view of the fact that the establishment of the process in America, France and Germany followed the development at Stanton, it is felt that it is particularly appropriate that the medal be presented to him in recognition of this work. The presentation will be made by Mr. E. J. Fox at the annual general meeting of the Institute.

Notes from the Branches

London.—The next meeting is to be held on Thursday, May 28, at 7.30 p.m., at the National Liberal Club, Whitehall Place, S.W.1, when Mr. D. Cherry Paterson, M.I.Mech.E., managing director of Paterson-Hughes Engineering Company, Limited, of Glasgow, is to present a Paper on "Mechanical Handling in Foundry Practice."

South Africa.—At the February meeting, presided over by Mr. J. Tonge, a Paper on a phase of pattern-making was read by Mr. West. Before the lecture, Mr. Stones was presented with the Institute's diploma. Notice was given that a prize competition was being held on the subject of "The Future of the Foundry Industry in South Africa." A proposal for the establishment of a metallurgical course on the Reef was favourably discussed.

LIGHT-METAL RESOURCES

German production of aluminium in 1943 is estimated at 300,000 short tons, an increase of only 35,000 short tons over the 1940 figure, while German production of magnesium, reported at 20,900 short tons in 1940, is projected at 40,000 short tons in 1943, according to American estimates presented in a survey of the light-metal industries. In both metals, Germany led the United States in output during 1940, the survey shows, but is completely unable to match American expansion plans. It is estimated that approximately 70 per cent. of the weight of fighter planes represent structural elements or parts fabricated from light metals. Dependent on the type of plane, aluminium requirements alone are estimated to amount to from 2.5 to 15.0 tons per airplane, and magnesium may be from 0.1 to 1.5 tons. In addition, magnesium in particular finds large military application in tracer bullets, flares, and especially in thermite or incendiary bombs. World production of magnesium was relatively small in 1929; in 1940, relative output of the Axis was greater than that of the Democracies. By 1943, production of magnesium in the United States will have been so increased that the metal available to the United States and its Allies is likely to be over five times that of the Axis.

CAST CRANKSHAFT

CHARLES HOEHN, in "Steel," states that shortage of cast-iron scrap has become a major problem in the production of iron castings, and is being met quite successfully by the substitution of more than 50 per cent. of steel scrap with the necessary cupola additions to develop the required metallurgical analyses. Shortage of aluminium has been met in a number of important cases, such as cast aluminium blower fans, by the substitution of thin rolled sheet steel parts electrically welded. Shortage of crankshaft forgings for Diesel engines up to 1,000 horse-power is being avoided by the use of special cast-iron and steel crankshafts. The use of exhaust gas superchargers on some Diesel engines is creating from 30 to 40 per cent. more horse-power for the same size and weight of engine.

CONTROL IN THE REPETITION FOUNDRY

DISCUSSION OF PAPER BY LANCASHIRE BRANCH

By A. B. Bill

(*Continued from page* 49.)

VOTE OF THANKS

MR. A. JACKSON (Accrington), in proposing a vote of thanks, said that the Paper was of particular importance to all those who were in normal times engaged in the production of heavy repetition work, even though it might not be of a similar type to that manufactured by the firm with which Mr. Bill was associated. British foundries were now making many thousands of parts from ordinary grey iron, and particularly so with irons of the hematite class. The statements in the Paper regarding inspection were very rightly stressed as being of great importance in regard to finding and analysing faults.

MR. J. LOWE, in seconding, remarked that there were certain methods of checking mentioned in the Paper with which he did not necessarily agree, and suggested the adoption of simpler methods for some jobs. He had not seen a scab on a casting for 17 years when made in a moulding machine. Hand-ramming, for which he did not care, was liable to cause scabs. It was essential to provide the machine moulder with suitable facing sand, as it represented about 75 per cent. of his job, if he had any skill at all.

DISCUSSION

MR. BILL briefly thanked the meeting, and commented upon the statement of Mr. Lowe that he had not seen a scab for a long time when using a power-operated machine. He was quite prepared to accept the statement, but he noticed that Mr. Lowe had subsequently said that the moulder should be supplied with a suitably-prepared sand. This latter point was one which had been referred to in the Paper. If the moulder was not serviced, scabs would occur, especially in the case of low-carbon irons. Mr. Bill also pointed out that in his own case high temperature and a certain amount of penetration made it necessary to use sand having a small grain size associated with fairly hard ramming.

Venting Foolproof Sands

MR. HAROLD HAYNES (Ashton-under-Lyne) asked why moulds should be vented if there was foolproof sand. It was sometimes found that a core-box would have to be made wrongly on account of the shrinkage of the core. Had Mr. Bill found this to be necessary in order to make his cores fit into the moulds? He could not agree with Mr. Bill's statement respecting liquid shrinkage in the casting illustrated by Fig. 4. He noticed the porosity was located at the bottom, where there was a runner. Was it the runner which was causing the porosity, or the metal employed?

MR. BILL agreed that it did seem somewhat strange to say that, even with a supply of foolproof sand, venting was still required. Although his firm were providing their moulders, to a very great extent, with a really good synthetic sand mixture, with a permeability, putting it on the safe side, of more than 50 A.F.A., nevertheless trouble ensued if a certain amount of venting was not undertaken. This applied particularly to flat, shallow jobs or on deep tapered cods where ramming was difficult to control. He was convinced, however, that quite a considerable amount of venting which was done to-day was carried on more from force of habit than from necessity. While some moulders could not be persuaded to use vents, it would be a good thing if others could be persuaded not to use them. Everybody would agree that too many vents were better than no vents at all, where they were necessary, but at the same time care should be taken to make effective and not merely useless whistlers.

MR. HAYNES said that it was not economical to interrupt the work of mass production, and therefore venting should be eliminated.

MR. BILL agreed, but said that there were many cases where venting could not be dispensed with no matter what the permeability and strength of the sand might be. He hoped that someone would be able to state the reason, and also perhaps someone might be able to state whether there really was a "foolproof" sand. The suppliers of some of the artificial clays for synthetic sands informed them they could work to 3 per cent. moisture, but so far they had had to allow for at least 4 per cent. With the excess moisture the amount of gases generated increased, thus reducing the effective permeability. He had had some small experience of designing himself. Since he had

Control in the Repetition Foundry

been entirely associated with the foundry, he had reflected that if he had only known what difficulties some of the designs he had made would create for the foundrymen, he would have endeavoured to deal with them differently. As a matter of personal pride, the average draughtsman liked his design to be symmetrical and to "look nice," and then the foundrymen perhaps objected to his design stating that it would be difficult to run it at a particular point. Nowadays, however, designers were found to be very amenable to suggestions of slight alterations in their designs, thus facilitating moulding operations.

Core-Working Difficulties

He had been asked a very vexed question as to whether a core was made wrongly in order to get the casting right. In the first place, his firm did not make any very big cores, and therefore there was not a great degree of shrinkage experienced. It was found that by the use of suitable carriers, whether they were of sand, metal or composition, no real trouble was experienced with sagging, although in extreme cases it was necessary to provide for this, and unfortunately it generally reduced itself to a matter of trial and error.

As to the question as to whether it was the runner which was creating the porosity indicated in Fig. 4, the runner bore no relation to its actual position on the job. It was simply and solely a case of the feeder being too small for the job.

MR. HAYNES thought the running was wrongly located. He personally would run the casting from the top.

MR. BILL replied that it was not a grey iron job, it was white iron for blackheart malleable. One difficulty with regard to top running would be the scouring effect of the metal. Runners were invariably placed on the joint line or at the bottom due partly to the risk of scouring and partly for feeding reasons.

In the case of the second example (Fig. 5), showing shrinkage, Mr. Bill explained that the reason for it was that the solidification of the casting was not progressive. The rapid freezing of the thin barrel-shaped centre portion precluded the possibility of feeding metal, passing through to the relatively heavy boss at the bottom. In order to equalise the cooling rates, therefore, a "chill" was used in the bottom. A feeder placed on the heavy flange at the top was sufficient to feed the centre section and the flange.

In reply to a question from MR. A. SUTCLIFFE (Bolton), MR. BILL pointed out that his reply to Mr. Haynes covered the point. The casting referred to had a certain amount of liquid shrinkage to make up. Had it been of relatively even sections then no matter where the feeder was placed it would supply feeding metal, or rather it would supply metal to make up for the liquid shrinkage of the casting. Unfortunately, the section was so thin at one part, that before the feeding metal had had time to get through to feed the shrinkage, freezing occurred, and the feeder could only feed the top flange. This difficulty could perhaps have been overcome if the customer or the designer had been willing to thicken that particular part of the section; the whole casting would then freeze more or less progressively. Unfortunately, they would not agree to this course being adopted. An alternative perhaps would have been to put in an extra feeder, but that was obviously not an economical proposition. Thus the rates of cooling were equalised by a densener so that the thin section could not draw feeding metal from the bottom section, and had to draw all its feeding metal from the top.

Filing of Cores Unnecessary

MR. SUTCLIFFE said he noticed that Mr. Bill did not do much mating of cores. The case of the long barrel core was one where it could be done with advantage. Then again, if there was a straight print on the bottom of a mould how would the moulder insert a core without sometimes loosening some sand if he did not taper it by filing?

MR. BILL replied that if a patternmaker made his pattern properly, allowing plenty of taper and plenty of venting, the moulder would be able to insert his core satisfactorily without disturbing any sand. If a mechanised foundry was as well equipped as it should be there should be no such faults as that; they could always be corrected in time. Referring to the mating and filing of the cores, he agreed that in the case of a jobbing foundry (if it was to be admitted there was such an establishment), the file was an indispensable moulder's tool. In the case of the repetition foundry, which Mr. Sutcliffe apparently despised, he did not think this should be necessary at all. since the ideal pattern equipment, cores, etc., should register properly without any cutting and carving by the moulder.

MR. SUTCLIFFE said it should not be necessary on any small job such as was shown in Fig. 4.

MR. BILL replied that this was a point he had made when he stated that prints and registers

Control in the Repetition Foundry

should be adequate and well matched. If they were, then surely there should be no necessity for filing. It was, however, the fact in his own experience that old-time moulders still insisted on using, say, a 14-in. file or perhaps a very large hacksaw to provide their own idea of crushing space. He was endeavouring, by degrees, to persuade them that the use of such tools was unnecessary, and he was achieving a small measure of success in that respect. He admitted it was small at the moment, but it was growing steadily. Possibly it was a case of force of habit due to the provision of poor equipment, cores, etc., in the past.

Coming to perhaps a more important point in Mr. Sutcliffe's remarks, he quite agreed that work in a repetition foundry could run itself. This was the sole object of its planning. Credit, however, must be given to the men who made the establishment of the repetition foundry a practical proposition.

Assigning Blame for Rejects

The question as to who was to blame for the rejects would, of course, depend upon the particular type of reject. It might be due possibly to lack of control by the chemist over his iron. In his own case, that particular field was almost perfectly controlled and practically no rejects occurred. In other cases, he thought it would be agreed that everything depended upon examination of the job. If cores were not properly mated then perhaps the fault would be due in a large measure to the patternmaker, while if there was a batch of oversized cores, due to irregularity in coremaking, surely it would be the coremaker's fault. If there was a pattern on which the moulder had used a 14-in. file to rub his print down, allowing the core to move in its print, then surely it would be the moulder's fault. The fundamental object was to produce a perfect mould; whether this consummation could be fully achieved was still a matter for conjecture.

Mechanical Venting

MR. JACKSON said one illustration of a casting shown was one of which he (the speaker) had seen many examples. Mr. Bill had stated this state of things was overcome by a system of hammering down a spiked plate in order to create a vent. Personally, he (the speaker) did not know whether he had tackled similar jobs on a wrong line or otherwise, but he had entertained a similar idea for a long time, and he had had the unfortunate experience of getting too much "pull-up" with sand. Mr. Bill had not stated in what particular line he rectified the vent by some mechanical means. If he had been able to do so, he (the speaker) would be pleased to learn what it was.

MR. BILL said they never made a venting jig for the particular job illustrated. In the case of the particular foundry with which he was associated, jobs did not lend themselves readily to that sort of thing, because there were so many of them, and it was not practicable to undertake the provision of venting jigs for the numerous jobs which had to be undertaken. Only in a few cases would it be possible to do so.

The first job in which he saw it done was an automobile cylinder, and in that particular case there was a jig which fitted over the pattern pins. It was a relatively elementary job and it had tapered vents, though not a large number of them. The jig came down to $\frac{1}{8}$ in. of the pattern face, and it definitely did away with any manual venting. Jigs had been used, with varying success, in the foundry with which he was associated. The job shown on the screen was definitely a nuisance. Only a relatively small number of castings were made, so that nothing was really done in the matter of inventing a suitable jig. A venting jig had been used on a repetition job, which was a casting weighing about 80 lbs. It was composed of a frame which registered with the pattern pins, but did not entirely cut out manual venting.

Moulding Machinery and Venting

MR. SUTCLIFFE inquired what was the weight of the casting which was shown with numerous vents.

MR. BILL thought it was about 151 lbs.

MR. SUTCLIFFE said he would not use a vent in that case.

MR. BILL said he would not do so either if he could have used a suitable type of sand at the time, but, unfortunately, that was not the case.

MR. A. L. KEY (Manchester) asked whether Mr. Bill was referring to mechanically-rammed vents or hand-rammed ones.

MR. BILL replied that there were mechanically-rammed vents.

MR. KEY said it was unnecessary to use a vent wire on a machine-moulded job, if the moulding materials were satisfactory.

MR. BILL replied that if the moulding sand supplied to the moulder possessed reasonably good characteristics, then there might be no need for vents, but, unfortunately, even in the best of well-regulated foundries, the sand which was available was sometimes unsuitable, or at any rate not good enough for repetition moulding. In such cases,

vents were necessary, at least in his own particular case. Perhaps half of the total production was effected by means of a synthetic sand mixture with a much higher permeability than that of the rest of the sand used in the foundry which was running on naturally-bonded sands. Vents were definitely required, and in quantity, with naturally-bonded sand. With a sand which was only just strong enough to hold in the boxes, the permeability was so low as to require vents. In the case of a synthetic sand, the permeability was higher, and venting was not so necessary, although often, even with these sands, it was considered advisable to resort to the venting wire. It seemed as though no one had yet produced a moulding machine which would ram a small mould properly, particularly on fairly deep snap flask work; the nearest approach to it being some adaptation of the down-sand frame. Primarily, his own firm was using squeeze, or jolt, or jolt-squeeze machines. There had to be a certain amount of ramming round the outside of the box, and if that was done by semi-skilled or totally unskilled boys, trouble often ensued. Given a perfect moulding machine, with a reasonably good sand, then perhaps there would not be any need for vents, but until that desirable consummation was achieved, there would be.

MR. W. BROWN (Manchester) referred to pulling up sand around the vents mentioned by Mr. Jackson. Bath tubs, for instance, carried mechanical vents exactly as described by Mr. Bill. They consisted of a series of taper vents on a grid which, in turn, ran through a second grid. The whole device was operated by means of a crane or mechanically-lifting arrangement. It was registered through the box, and it came up about 3 in., and the secondary jig came up with the lot. The taper allowed the first lift, which was drawn through the holes in the secondary jig, and the whole came together.

MR. KEY had also seen this done, but it was not applicable to the case he had in mind.

The "Rosette" Core

MR. MORRIS referred to the "rosette" core (Fig. 15), and pointed out that three cores had been put in the mould. Would it not have been better to have split a core vertically and dry the two halves to form one core instead of using three separate cores and the jig?

MR. BILL thought perhaps it might be pointed out that the object of this illustration was to show the simple gauging of the core rather than the method of making the core.

MR. BILL then drew a diagrammatic sketch of the centre core in question. Referring to it as the "rosette" core, he would not state that it was impossible to make the core by splitting vertically on the centre line, but pointed out that although three cores were used, only two coreboxes were needed since the top and bottom cores were identical. He assumed it was thought easier to dry smaller cores without sagging or trouble due to warped core plates.

It would have entailed the use of loose piece or "draw ins" to make the core in two halves, and suggested that in any case it would be better to leave an excess of sand on the joints of the two dried half cores and rub this off in a jig afterwards to ensure accuracy. Had Mr. Morris considered that the centre core only might have been used and the top and bottom bores moulded?

Cause of Scabbing

MR. KEY asked what was the nature of the scabbing which had been mentioned? Was there a solid scab or a blister scab?

MR. BILL said that opinion was divided. Those of which he had experience in the past, and to a certain extent in the present, particularly in the use of naturally-bonded sands, were due to the impermeability of the backing sand. The gas from the facing sand, whatever it might be, could get through to the backing sand, and could push a small proportion of the facing sand into the casting. He might be wrong about this, and he remembered hearing a very lengthy argument by Mr. Herd upon the subject; but he firmly believed it was the case; namely, that it was due to the impermeability of the backing sand in cases where both backing and facing sand were used. It might be due to the backing itself, the method of ramming, or to the moulder, or the moulding machine.

MR. KEY asked whether it was a rough part of the casting where the sand had washed away? Was that the appearance of the scab?

MR. BILL said it was not. In the majority of cases it was more or less of a shell of metal over the face of the casting, with little bits of sand scattered about the casting itself. There was a definite lifting of the surface with loose sand or a pocket of sand about the casting.

MR. JACKSON said that was what was termed a blister scab.

MR. KEY asked what control there was with regard to backing sand in respect of moisture?

MR. BILL said it varied according to the sand used, and pointed out that enough moisture had

to be allowed to make up for evaporation since it was not kept in bins.

Preparation of Backing Sand

MR. KEY asked whether the backing sand was prepared beforehand, or was its preparation left to the judgement of the moulder or the mixers.

MR. BILL said that in some cases the preparation of the backing sand was left to labourers who just broke down the spent sand, tempered it, and delivered it to the moulder again. In some cases there was a really carefully-prepared sand mixture. In all cases it was prepared and was delivered to the moulder. Of course, with batch melting there was no continuous preparation, and the sand had to stand for a comparatively long time. Therefore it was necessary to resort to a batch preparation of the backing sand.

MR. SUTCLIFFE asked whether the scabbing was on the flat surface?

MR. BILL replied that that was usually the case, but not necessarily, and often occurred on a tapered mould or possibly those made on a jolt machine, being caused by facing sand jolting away from the pattern, leaving part of the face covered only with backing sand.

MR. SUTCLIFFE understood that Mr. Bill dealt with a continuous casting plant. How did he control the analysis of the metal?

MR. BILL said he had not mentioned a continuous casting plant; as a matter of fact he had stated that the foundry was restricted to batch melting. In any case, the analysis of the metal was something which was entirely out of his sphere, and was controlled by one of the most eminent metallurgists in the country.

MR. KEY said there were two forces causing scabs. The sand might be too damp or it might be too dry. If the sand was not sufficiently elastic to take up a surface expansion that was, primarily, a cause of scabs. He referred to surface expansion on the facing sand. Having this in view, it was only a question of pursuing the matter, and he thought a great deal of information would be obtained by the investigator. He had proved his point in a number of cases.

MR. BILL said that, as a matter of fact, he found it difficult to agree wholeheartedly with Mr. Key as to the particular causes mentioned. He found scabs were formed more often with a naturally-bonded sand. The naturally-bonded sands were used again and again, additions being made, of course, to the backing sand and the facing sand, of naturally-bonded sand in which the grain size was definitely very variable. He was under the impression that the majority of experts on sand control agreed that the elasticity of sand depended to some extent upon its grain size, and they agreed that with a mixed grain size, namely, small grains interspersed with large grains, there was a greater ratio of elasticity. It might be assumed that when sand was used over and over again there would be a continual breaking down of the grains.

MR. HAYNES asked whether the patterns were made of metal?

MR. BILL said that some were made of metal, and others of wood.

MR. HAYNES said that ramming, with a springing wood pattern, would cause scabs. Metal patterns for machines were really better.

Patterns for Quantity Production

MR. BILL could not altogether agree that metal patterns were best for machines. He agreed that possibly, in the long run, a metal pattern was best for production moulding. Personally he preferred a metal pattern; but all the same as many as 10,000 moulds had been made off a wooden pattern in his foundry, and it could therefore be considered as being just as good as a metal one, although the pattern needed renovating more often.

Answering Mr. Sutcliffe, MR. BILL stated that the sand was milled. It was considered that what was necessary in the case of a moulding sand was to distribute the bond evenly, or as evenly as possible, over the basic sand grains. The amount of new naturally-bonded sand additions which were made to any particular moulding sand which had been kept for further use depended obviously on the state of the sand. It depended upon its permeability, on the strength of the sand, as to how much bonding strength was given to it. It would not be possible to give a mixture off-hand. There was, of course, no waste of sand at all in the case of synthetic mixtures; proportions of bonding material were added as the strength of the sand deteriorated. The firm with which he was associated had been running the system for a long time now, and he did not think they had wasted any sand at all; in fact, they clung to their spent sand and relied upon it more or less for breaking down grain size in order to furnish a certain amount of elasticity. It was found that with all new synthetic sand mixtures there was a certain amount of difficulty in moulding. They did not appear to flow so well as a naturally-bonded sand, so that the firm clung to their fines in order to improve the elasticity and flowability.

BURNING-ON REPAIRS

By JAS. TIMBRELL

Burning-on a new section of cast iron to a casting, by pouring over the damaged part high temperature metal to bring about a homogeneous repair, has long been an accepted practice, where the heavier type of work is made. There is some prejudice against burning-on from the engineering side, which is understandable when the process is done by pouring on metal and relying on the height and velocity of the stream to wash out and melt enough surface for the burn to end by being a sound job when completed. Minute holes and hardness are associated with the method of repair, moreover the quantity of metal required for the process will heat up a much larger local area than is safe, if cooling off cracks are to be avoided.

Not all foundries possess a welding plant suitable for cast iron, and even where this method is permissible, to weld successfully much specialised experience is necessary. In cases where a feeder is broken in, a corner broken off, or a casting is cracked, burning-on can be successfully done in many instances, if close attention be given to the laws of rapid expansion and local contraction to be associated with the process. This article has been compiled from records of satisfactory repairs by burning-on. The method as described is applicable in principle to many types of castings which for obvious reasons are considered scrap.

The theory behind the process is shown by the sketch Fig. 5, which represents the most difficult type of weld. The faces inside the crack are rendered pasty by pouring hot iron between them to be run off at the hole at the bottom, into a gutter and thence into a "grip" or ridge in the floor. Very little metal is required to melt the sides of the crack (the amount is according to the section thickness), the drain hole is botted up and pouring stopped after filling the space, plus filing or machining allowance. The run off "jug" is broken up and pieces placed on the burn to keep this in expansion, other pieces or "hot heads" are placed all alongside to set up expansion in these parts of the cold casting, and the whole allowed to cool off slowly.

Tradition insists that a casting requires to be buried

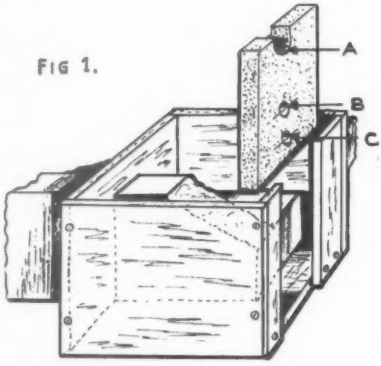


FIG 1.

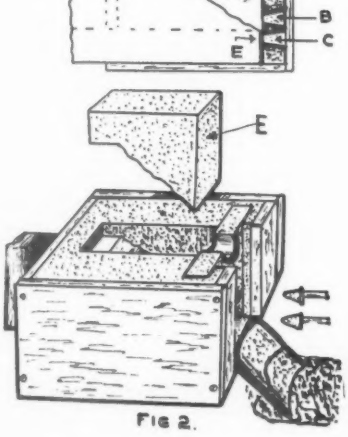
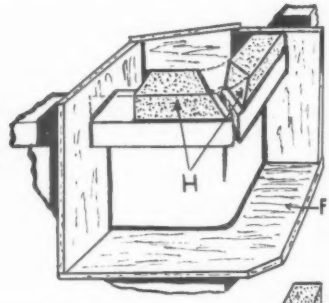


FIG 2.



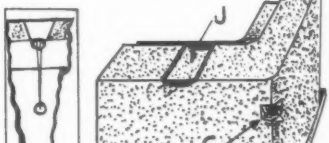
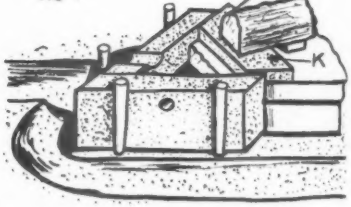


FIG 3.

FIG 4



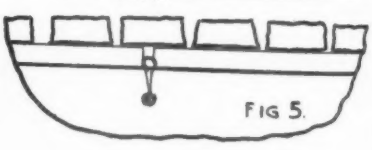


FIG 5.

Burning-on Repairs

and heated up prior to burning-on. The part to be renewed is rammed up and a suitable shape cut out adjacent to the break. With the bottom drain method this is unnecessary, and the heating up is not advised because the pouring-on heats it still more and during the cool-off may separate the burn from the casting.

Fig. 1 shows a simple type of repair. A corner was broken off a casting which had been machined and erected. Several of the units fixed to this were left in place and to keep these free from foundry sand the unit was placed on a bogie and brought under the crane alongside the cupola. A rough wooden box was cut as shown, and fixed in place. A slab of good loam cake was trimmed to fit and two holes for drains, B and C, and a run off, A, were formed. This was fixed in the box. A piece of core filed up to represent the missing corner, plus machining allowance (E, Fig. 2), was fixed on the casting and the inside of the box rammed up, as is shown in Fig. 2. The position of the drain holes is shown, bottom sketch Fig. 1. A run-off gutter was lined up to take the flow into a ridge in the floor. A pencil stream of metal at 1,450 deg. C. was directed across the face of the fracture, and this metal run out of drain hole B. Immediately the flow commences to run out of hole C, giving evidence that the break is pasty, holes B and C are botted up and the flow continued a few seconds. The run-off A determines the amount left on the top (D). to be fettled off or machined. The run-off pig is broken up and placed on the burn and the surrounding area and the whole left to cool off slowly.

Fig. 3 shows a corner crack in a heavy gearbox; three of these were saved by the method shown. A wooden frame, F, to half surround it, and a core, G, dried, and drain holes drilled in appropriate positions. Two pieces of loam cake, H, were added to form a runner and also to prevent the stream from melting the top flange more than is necessary. The top run-off is filed out to allow for machining and to run off into a gutter at a suitable point. The same routine as before explained is carried out. In both cases, no metal should run out of the bottom drain hole until the casting behind is melted away sufficiently to release the flow.

Fig. 4 shows a heavy marking-out table with a corner broken off; this also was made sound by the same method. In this case the casting can be laid floor level; blocks of loam cake secured in position by rods; the drain hole drilled in place and the run-off filed out to suit. The slab K is held in position by a suitable weight as shown. Burning-on by the methods described will be found to be easily filed or machined up and beyond a closer grain immediately by the previous break and a slightly higher Brinell reading, no other evidence is discernible.

WASTE PAPER IS A VITAL WAR MATERIAL
— SAVE IT FOR MUNITIONS —

BORON ADDITIONS TO CAST IRON AND STEEL

Dealing with the use of boron in steel and cast iron, NORMAN F. TISDALE, in "Metal Progress," reports that work at the University of Pittsburg shows that excessive amounts of boron (even 0.03 per cent.) in iron and steel caused hot shortness. This property is usually attributed to the formation of an envelope of insoluble material around the grain boundaries. The presence of iron sulphide in the grain boundaries of steel is the classical example of this effect. Boron, when used in excessive amounts, is no exception to this rule, because of the precipitation of films of a constituent, thought to be a solid solution of iron carbide and iron boride.

As long as the grains are not completely surrounded by this embrittling constituent, no red shortness is encountered. In some steels, as much as 0.008 per cent. boron may be present without the formation of this closed envelope, but less than 0.003 per cent. is generally recommended and is being used commercially by a number of steel companies at present. In this small quantity boron has been found to be beneficial. There is some indication that by such additions the tensile strength is increased without noticeably changing the reduction of area or elongation.

Increased physical properties account for the use of boron in crankshafts and other automobile parts. It has been used successfully in hot-rolled spring steels of large cross-section to increase hardness penetration (hardenability). The need for conservation of chromium has led to the development of new manganese-molybdenum-boron steels in which the major alloying elements are kept on the low side of their normally specified ranges, thus resulting in a desired economy.

In cast irons, 0.02 to 0.10 per cent. boron is used effectively with beneficial results, since large amounts of iron carbide (Fe_3C) are present to hold the iron boride in solid solution. This element inhibits graphitisation, thus tending to produce white fractures in which the carbon is present in the combined form. Boron, therefore, acts as an agent for the control of depth of chill in iron rolls, and also increases surface hardness. Previous investigators have shown that the complex carbide (Fe_3C-Fe_2B) exists when boron is added to cast iron, and is responsible for the above effects.

New developments in the method of adding boron to iron and steel are also responsible for the commercial success of this element. A recently developed ferro-boron containing 10 to 14 per cent. boron has resulted in higher efficiency and greater recovery than was formerly effected when borates or boron ore were used as addition agents. This low melting point ferro-boron dissolves readily in the steel, and the boron acts as a ferrite strengthener and an agent in the formation of complex carbides. Research is now in progress for the use of this element in plain carbon, as well as in alloy, steels and irons.

WORKERS' CLOTHING COUPONS

FOURTH SUPPLEMENTARY AWARD

The Board of Trade have now decided to make a fourth award of extra clothing coupons to certain types of workers who have not already received extra coupons. Workers who are entitled to coupons will receive them irrespective of sex. The extra coupons will be issued through the Ministry of Labour and National Service to employers only, who will distribute them to the workers who should receive them. Local offices of the Ministry of Labour are not authorised to deal with direct applications from individual employees.

Employers must make application on form E.D. 272, obtainable from their nearest local office of the Ministry of Labour, and which must be completed in duplicate and returned to that office immediately. It will not be possible to make any adjustment of the number of coupons to be received by any worker after form E.D. 272 has been sent in by the employer.

Following is an indication of the workers covered by the new award, but the full list available at local offices should be consulted by employers. It is emphasised that no worker who has received coupons under any award made by the Board may receive further coupons under this or any other award.

Engineering Production Shops (including Aircraft).—Workers wholly engaged in operating machines involving constant splashes by cooling lubricant, electro platers, platers (non-electrolytic), close platers, enamellers, and workers doping aircraft, 15 extra coupons.

Paint sprayers, burrers, and heavy machine shearers, 10 coupons.

Shipbuilding and Repairing.—Ten, 15, 25 or 30 extra coupons, according to the nature of the work.

Ferrous and Non-Ferrous Stockyard and Warehousing Workers.—Acetylene burner, 25 extra coupons.

Labourer (slinging, lifting, stocking, loading and unloading wagons of steel bars, plates, joists, section, etc., including bright steel; re-greasing; marking; painting), steel sawyer, cropper, maintenance fitter, shearer, and puncher, 15 coupons.

Polishing, Plating and Colouring of Metals.—Scourer (including de-greaser), 30 extra coupons.

Polisher (spindle), grinder (on metal polishing), electro plater, close plater, dipper, oxidiser, polisher (flexible), buffer, plater (non-electrolytic), depositor, bronzer-dipper, 20 coupons.

Labourer handling acids, 15 coupons.

Polisher (machine), sprayer, 10 coupons.

Graphite, Carbon and Carbon Goods Manufacture and Charcoal Processing.—Ten to 30 coupons.

Manufacture of Aluminium.—Furnaceman, smelter, paste squad, pickler, pitman, second furnaceman, tapper (except driver), cleaner, melter, frame charger, charger, 35 coupons.

Hammerman, de-dimpler and helper, vertical furnace loader, labourer working at: (1) horizontal and ageing or airsheet furnace, (2) nitrate furnace; roll flattener and helper, pit furnaceman, drier, drill puncher and helper, nitrate furnaceman, horizontal and ageing furnaceman, 30 coupons.

Moulder, dross unloader, hot roller, heater, annealer, helper on hot mill, draw bench cleaner, pourer, heat weigher, table hand, 25 coupons.

Hot sawyer, stretcher, dimpler, chipper, bow drawer, inspector and helper (heat-treatment only), de-twisting machine operator, die caster, slitter, scratch brusher, dresser, greaser, hot band sawyer, spindle machine operator, coke furnaceman, fireman, plater, scaler, operator and helper on machine involving use of acid, press driver, 20 coupons.

Alumina squad (except driver), trucker, knocking-out coreman, process labourer on hot processes, cold sawyer, scrap loader, tagger, blacksmith and striker, rigger, tapper driver, sheet shearer, behinder or catcher (hot), slinger, swarfman, router, cable gang, billet packer and handler, repair squad, coremaker, flattener (hot), trucker, strainer, maintenance fitter and mate, billet loader and unloader, 15 coupons.

Boiler house attendant, 10 coupons.

Heavy Machinery Moving, Erection and Dismantling.—Machinery erector and mate, machinery dismantler and mate, other workers engaged in loading and unloading heavy machinery, 20 coupons.

Bricklayers.—Bricklayers and bricklayers' labourers wholly engaged in building and maintenance of furnaces, retorts and kilns, irrespective of the industry in which they are engaged, 20 coupons.

Maintenance Electricians and Mates.—Collieries (surface), gas, ship repairs, coke and by-product, tar distillation, 15 coupons.

Pig-iron, coke and by-product, steel melting, ferrous and non-ferrous rolling, wrought iron, tinplate, sheet steel and galvanising, tube manufacture, shipbuilding, railway shops and loco. building and repairs, abrasives, electric cablemaking, drop forging, coil spring, welding ring, light forging, foundries, press shops, non-ferrous refineries, engineering production shops, electrical engineering and supply, wrought light alloys, 10 coupons.

Maintenance Fitters, Maintenance Engineers and Millwrights (and their Mates).—These workers will receive 15, 20 or 25 coupons according to the industry in which they are employed.

Boilermaking and Repairs.—Fifteen or 25 coupons.

Foundry Blacking and Sand.—Workers wholly engaged in the mixing and preparation of foundry facings and sand, involving the pulverising and handling of coal and other carbons, and workers on case hardening, involving use of oil and charcoal, 15 coupons.

Miscellaneous Occupations in the Metal Trades.—Slag wool furnaceman and melter, 30 coupons.

Springsmith, springmaker, spring striker, billet caster in non-ferrous foundries, anodiser (employing sulphuric acid method), marine propeller shaper, painter of non-ferrous tubes or sheets, 25 coupons.

Dresser, fettler, trimmer, chipper, employed in non-ferrous foundry, 20 coupons.

Pipe binder, roll turner, angle iron smith, draw bench hand (shop fittings trade), 15 coupons.

Electric grinder, emery wheeler, dry grinder, workers engaged on inspection of heavy shells (weighing 25 lbs. or over), involving lifting, 10 coupons.

STANTON *Dale* REFINED PIG IRON

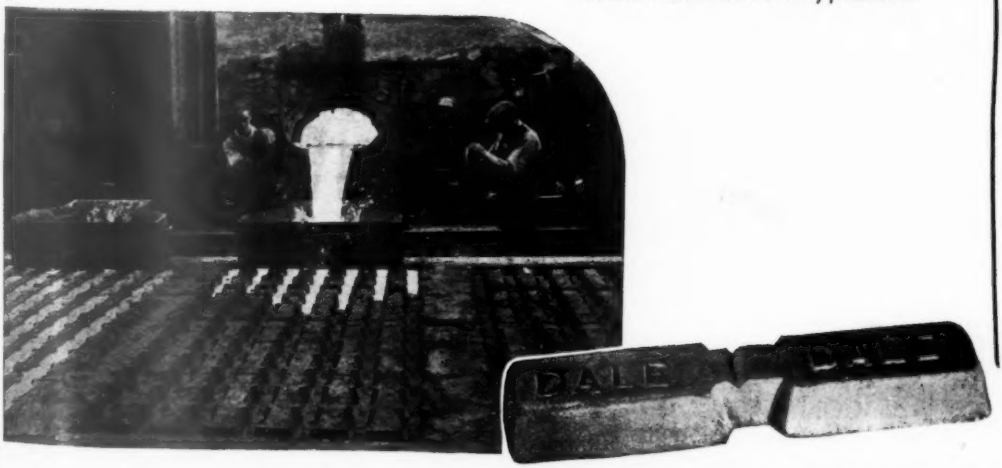
IS CHARACTERISED by closeness of grain structure, uniformity of composition and fine graphitic carbon evenly distributed.

IS PRODUCED to guaranteed analysis in seven standard grades.

CAN BE MADE to customers' individual requirements with total carbon from 2·6 per cent. upwards.

SHOULD BE USED to tone up high phosphorus irons and scrap, to replace Hematite, and to produce castings for all high duty purposes.

Users are invited to avail themselves of the Stanton Technical Service which offers free expert advice on special mixtures and other Foundry problems.



THE STANTON IRONWORKS COMPANY LIMITED, NEAR NOTTINGHAM

NEWS IN BRIEF

A BLOCK of 130,000 5s. ordinary shares in Range Boilers, Limited, is being placed on the London market.

A CLAIM by Cumberland iron-ore miners for an all-round increase in pay of 1s. 8d. a day has been referred to the Conciliation Board for arbitration.

WHEN A RUMOUR arises in the Lockheed Aircraft Corporation's works, the originator is now invited to write it up on a blackboard and sign it. The blackboard still retains virgin newness.

EMPLOYERS ARE REMINDED that May 16 is the last day for the receipt of applications for deferment of the calling up of men who cease to be reserved on June 1 under the scheme for progressive raising of ages of reservation.

ROHSTAHLGEMEINSCHAFT, the German iron and steel cartel, has extended its period of operation by another two years to June, 1944 Many of the allied associations are being rationalised, and the number of standard rolled products is to be further reduced.

IN THE ANNUAL REPORT of the Shipwrights' and Shipconstructors' Association, Mr. J. Willcocks, acting general secretary, advocates the publication of more details of shipping losses so as to give shipyard workers a more definite picture of the task they have to shoulder.

THE MINISTRY OF PRODUCTION has informed the British Standards Institution that the Government recognises the Institution as the sole organisation for the issue, in consultation with any Government, professional or industrial bodies concerned, of standards having a national application.

UNDER the Export of Goods (Control) (No. 22) Order, 1942, which comes into force on May 19, export control is extended to cover iron powder (or dust); weighing machines, balances and scales; metal fittings for luggage; electric lamp caps and certain kinds of metal furniture and metal haberdashery.

MR. A. CALLIGHAN, general secretary of the National Union of Blast-furnacemen, Ore Miners, Coke Workers and Kindred Trades, reporting to a Middlesbrough meeting of the Cleveland and District Delegate Board, said that this was the 21st year of the National Union and that their assets now exceeded £103,000. Mr. Callighan mentioned that they had secured trade union recognition for the members employed at the blast furnaces and coke ovens of the Clay Cross Company and had also entered into a comprehensive agreement at the Sheepbridge works under which the firm agreed to observe the terms of the national agreements.

CONTRACT OPEN

Belfast, May 21—Iron castings, service and condenser tubes, flexible metallic tubes, cast-iron pipes, compo. pipe and pig-lead, etc., for the Town Council. The Engineer and Manager, Gasworks, Ormeau Road, Belfast.

EMPLOYMENT OF WOMEN

The Minister of Labour and National Service has issued an Amending Order to the Employment of Women (Control of Engagement) Order, 1942. The principal amendment is the extension of the scope of the Order to include women of 18 and 19 years of age. This will mean that, save for women with young children of their own living with them, and certain other excepted classes, the Order now applies to the employment of all women aged 18 to 30 inclusive. Girls of 18 and 19 will thus in general be required to obtain their employment through a local office of the Ministry of Labour and employers will only be able to engage them by applying through a local office. Engagements of girls of 18 and 19 have until now been controlled only in the engineering, building, civil engineering, electrical contracting, coal-mining and shipbuilding industries, by means of the Undertakings (Restriction on Engagement) Order and the respective Essential Work Orders.

HAULBOWLINE STEELWORKS

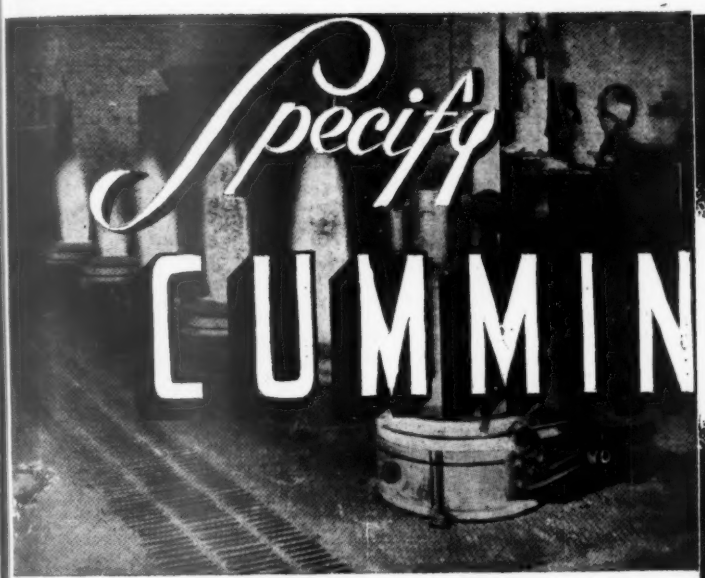
Mr. Vincent Crowley, receiver of Irish Steel, Limited, Haulbowline, has informed Cork Harbour Board that he had been unsuccessful in finding a purchaser for the company's assets, but following an approach to the Eire Minister for Industry and Commerce, the Minister had agreed to provide the necessary Government guarantee of £200,000 to enable the works to start the manufacture of steel from scrap metal available within the country. Conditions imposed by the Minister included the retirement of the existing receiver, securing the proposed loan by a first debenture, the appointment of a new board of directors nominated by the Minister, and creditors to accept debentures for their claims. Meetings of the debenture holders are to be held to obtain their views on the proposal.

BUSINESSES CLOSED BY THE WAR

Mr. F. B. Bessemer Clark, of F. A. Clark & Son, Limited, Phœnix Lead Mills, London, W., announcing that his company have been forced to stop manufacturing, suggests that it is only fair that businesses which have had to close down through Government action should receive pecuniary compensation from the State. The firm manufacture sheet lead and lead pipe and have been in business for 132 years. Owing to restrictions recently imposed by the Controller of Non-Ferrous Metals, the company have decided to stop manufacturing, the amount of business they are allowed to carry out involving them in a serious loss.

New Scrap Metal Order

Under an Order made by the Ministry of Works and Buildings, every occupier of premises in certain specified areas of the United Kingdom must furnish a return of any accumulation of 3 tons or more of metal suitable for scrap. Further details may be seen in the Ministry's announcement elsewhere in this issue.



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COMPANY NEWS

(Figures for previous year in brackets.)

Richard Johnson & Nephew—Ordinary dividend of 9% (same).

F. Reddaway & Company—Dividend for 1941 of 8% (same).

Lake & Elliot—Interim dividend of 5% on the ordinary shares.

Pressed Steel—Net profit for 1941, after taxation, £170,615 (£162,827).

Coventry Machine Tool—Net profit for 1941, £5,257; dividend of 8% (nil).

Heatrae—Net profit for the year ended February 28, £9,898; dividend of 12½%.

Metal Agencies Company—Final dividend of 16½% (11½%) on the ordinary shares, making 20% (15%).

Glenfield & Kennedy—Net profit, £68,615 (£67,537); final dividend of 5% and a bonus of 10%, making 20% (same).

Bede Metal & Chemical—Net profit for 1941, £5,712 (£9,804); dividend of 9d. (1s.) per share; forward, £8,252 (£9,083).

Tube Investments—Interim dividend on the ordinary stock of 10% and at the same rate relatively on the liaison ordinary shares.

Richard Thomas—The fixed dividend at the rate of 6½% per annum on the preference shares, in respect of the half-year ended March 31, 1942, will be paid on June 1.

Quirk Barton—Trading profit for 1941, £6,056 (£10,795); investment income, £3,427; taxation, £2,600; depreciation, £1,750; dividend of 8½% (same); forward, £20,256 (£20,732).

Hopkinsons—Profit for the year to January 31, 1942, £294,011 (£240,600); taxation, £238,795 (£136,496); final ordinary dividend of 10%, making 15% (same); forward, £73,260 (£56,544).

Central Provinces Manganese Ore—Trading profit for 1941, £566,538 (£568,199); final dividend of 15% (same), free of tax, making 22½% (same), tax free, for the year; forward, £120,930 (£102,135).

Yorkshire Engine—Trading profit for 1941, £6,169 (£6,681); reserved for taxes, £6,000; two years' preference dividend, £1,500 (same), leaving arrears as from December 31, 1932; forward, £5,770 (£7,101).

Bairds & Scottish Steel—Trading profit for 1941, after tax, depreciation, contingencies and war damage contribution, £80,288 (£136,270); final dividend of 3%, making 5% (8%); forward, £65,516 (£61,229).

William Dixon—Net profit for the year to February 28, after providing for depreciation and taxation, £39,986 (£45,360); dividend on the 5% cumulative preference stock, £7,500; final dividend of 6% (same) on the ordinary stock, making 10% (same); forward, £30,859 (£31,172).

Johnson & Phillips—Profit for 1941, £502,375 (£491,302); debenture service, £22,000 (same); depreciation, £31,749 (£32,181); pensions and assurance, £7,746 (£5,077); A.R.P., £7,406 (£10,662); taxation, £260,000; net balance, £165,987 (£154,572); ordinary dividend of 15% (same); to special reserve for contingencies, £30,000 (same); forward, £102,478 (£106,026).

PERSONAL

MR. J. H. ALLEN, a director of Barker & Allen, Limited, nickel silver manufacturers and sheet metal rollers, Birmingham, has been re-elected president of the Birmingham Chamber of Commerce.

MR. H. D. RICHARDSON, of George Cohen, Sons & Company, Limited, formerly manager of the firm's machinery department at Sheffield, has been appointed to a new post at their Stanningley Works, near Leeds. He will be specially concerned with colliery plant and machinery.

MR. A. J. EDGAR has resigned his position with the General Railway Signal Corporation, Rochester, N.Y., and has joined the staff of the Gray Iron Founders' Society. His duties include the expansion of the use of grey iron in the manufacture of armaments and especially where they can open up bottlenecks in production.

Wills

REED, SIR JOSEPH, of Seaton Burn, a director of Hepworth & Grandage, Limited, and other companies £88,590

HUMPHRIES, T. B., a director of the Wolverhampton Steel & Iron Company, Limited, and a former Cardiff shipowner £48,745

IN PARLIAMENT

Scrap Metal from Disused Plant

MR. PRICE asked the Parliamentary Secretary to the Ministry of Works and Buildings whether he would take steps to make use of the large quantities of salvage iron that were available in the disused Portland cement works at Mitcheldean, Gloucestershire.

MR. HICKS said that negotiations which it was hoped would result in the recovery for scrap of a large amount of the obsolete plant at Mitcheldean were being actively pursued with the owners.

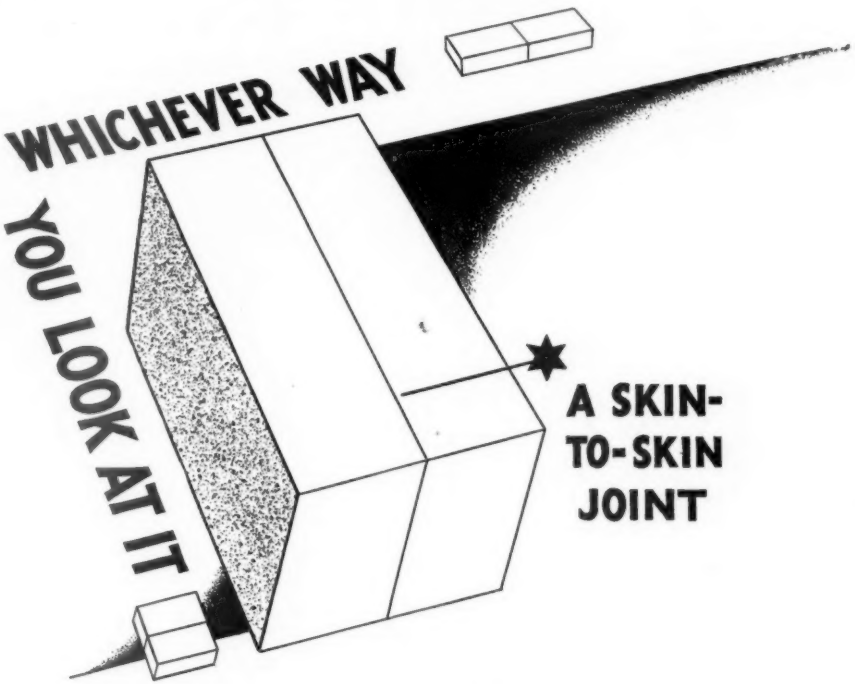
Raw Material Controllers

SIR ANDREW DUNCAN circulated by request a list showing which of the 21 controllers of raw materials in his department are paid a salary by the Ministry of Supply. None of the controllers associated with the iron and steel and non-ferrous industries was so listed.

OBITUARY

MR. DAVID KEIL TULLIS, of D. & J. Tullis, Limited, Kilbowie Ironworks, Clydebank, died on May 2, aged 75.

MR. FREDERICK HUGGINS, one of the tube trade's oldest members, died recently. Mr. Huggins was in the steel tube trade from his earliest days after leaving school until a few years ago, when he retired from business. A director of the Britannia Tube Company, Limited, and for many years of Simplex Conduits, Limited, he was chairman of the Close Joint Steel Tube Association for fourteen years.



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ALLEN. Like Lowood, these are widely used in converters, open hearth and electric furnaces, and glass tanks. Modern methods of manufacture ensure the production of uniformly well-fired bricks of low porosity and perfect finish.

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G. R. Silica Bricks are recognised and widely accepted as refractories possessing these qualities. In addition, they are uniformly consistent as regards refractoriness-under-load, bulk density, high degree of conversion, and volume stability at melting temperatures.

When you build with G.R. Silica Bricks you build with assurance and confidence.

FIREBRICKS · BASIC BRICKS · ACID-PROOF
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Raw Material Markets

IRON AND STEEL

Productive capacity is still being extended, and every opportunity taken to enlarge the outputs of the various grades of iron and steel used in the production of munitions and other essentials of war. Efforts are being made to reduce imports from the United States to the bare minimum necessary to make up deficiencies of home output in particular directions. The authorities still hold stocks of foreign material brought over when there was more shipping space available for such cargoes than there is to-day, but this material is being distributed with very great care, as it will not be replaced. Engineering foundries have been compelled to adapt their works' practice and to modify their specifications in order to incorporate additional supplies of home-produced irons and, generally speaking, they have done this successfully. The use of high-phosphorus iron in the heavy foundries has been extended very considerably, owing to the shortage of low-phosphorus and hematite irons. In normal times only small quantities of high-phosphorus iron are utilised, this iron being taken up mainly by the light-castings makers. The latter are not now in the market for their customary requirements, as trade has fallen away appreciably since the war started, the products of the majority of these works being of little use to Government departments. In a few instances, where light founders have been able to adapt their plant to cope with special war needs, the works are well situated for business, but this has not been the general experience in this trade.

Ample supplies of foundry coke are being delivered to users, and stocks are being augmented in many instances as a precaution against delays in deliveries in the future. Many consumers were kept waiting for fresh tonnages during the early part of the year, but their ground stocks generally enabled them to continue operations unhampered.

Production of the various qualities of steel required for the war effort is well maintained, and is, in fact, being enlarged at every opportunity. Special alloy steels are in great demand, and the industry is now largely concentrating on their manufacture. Structural engineers are calling for quite substantial supplies of joists, small sectional materials, etc., and their needs are greater than in the first quarter of the year. Plate mills are fully employed on steel for the shipyards and other sources of consumption of heavy plates.

Since the inception of the national scrap collection campaign very large tonnages of metal have been found, but owing to the shortage of labour, a certain amount of delay is experienced before this metal becomes available to consumers, as first it has to be sorted and classified. On the whole, merchants appear to be coping with their commitments satisfactorily, but the demand shows no sign of abating, especially for steelworks' descriptions. Some ironfoundries have as much metal on hand as they can deal with, and has suspended further deliveries for the time being, but this is not likely to be more than a temporary phase.

NON-FERROUS METALS

The report for 1941 of the Tin Research Institute states that since Japan began the Far Eastern campaign the main problem has become how to make the best use of supplies by curtailing the use of tin in commodities not essential to war, by improving the processes in essential uses, and by recovering tin. During 1941 the Institute's hot-tinning plant was in continuous operation and much assistance was rendered to manufacturers in tinning some kinds of steel which have hitherto been difficult. The Institute has been appointed by the Ministry of Supply to advise on all technical questions affecting the use of tin.

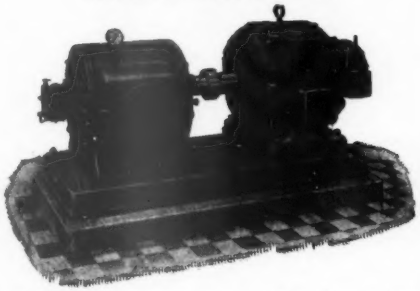
The British occupation of Madagascar will be welcomed in copper circles, as it should mean that shipments of the red metal from the East African port of Beira will be subject to less risk than before.

The fate of the Burma Corporation's mines at Bawdin has been determined by the fall of Lashio and important mineral gains have been made by the Japanese. It has been announced that the Corporation's properties were evacuated on April 25. The Bawdin mines were capable of producing, on an annual basis, 80,000 tons of lead, 45,000 tons of metallic zinc, more than 6,000,000 ozs. of silver, and quantities of copper matte. The company's smelters at Namtu have been destroyed and the mining equipment wrecked, and it will be a long time before the acquisition of the property will be of any considerable use to the enemy's war effort. At the same time, before the fall of Rangoon the entire lead and zinc output of the Burma Corporation was at the disposal of the British Government. Now the preservation of the Australian lead and zinc resources is of paramount importance to the Allies. Japan herself must be living largely on stocks. The lead production of Japan and Korea is less than 20,000 tons a year, while zinc output is estimated at just 20,000 tons. In late years the zinc smelter output, partly based on imported concentrates, has been up to 50,000 tons, or less than half of Japan's requirements. The deficiency in lead is much greater, Japanese consumption of this metal being more than 125,000 tons a year. Thus, it has been necessary for Japan to import substantial supplies of lead and zinc and these she has acquired, in normal times, from Australia, the United States, Mexico, India, Canada, and European sources. Since these supplies have been denied to Japan big withdrawals have been made from her reserves.

American Fluorspar in 1941.—The American fluorspar industry supplied a record demand in 1941 from steelworks, aluminium plants, and manufacturers of glass, enamel and hydrofluoric acid, states the Bureau of Mines. Deliveries in 1941, at 320,669 short tons, were 37 per cent. greater than in 1940, and 22 per cent. above the previous record in 1918. Sales of imported fluorspar were 31 per cent. less than in 1940. Of total supplies, steelworks took 214,120 tons, foundries 2,724 tons, glass and enamel makers 32,051 tons, and HF makers 52,674 tons.

ROTARY COMPRESSORS

ROLLING DRUM TYPE



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'Phone : HIGH WYCOMBE 1792 (3 lines).

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Chairman : FitzHerbert Wright, The Butterley Company, Ripley near Derby. Secretary : V. Delport, 2, Caxton Street, Westminster S.W.1.

Participating Associations : National Ironfounding Employers' Federation ; British Ironfounders' Association ; National Association of Malleable Ironfounders ; Ironfounders' National Confederation ; British Bath Manufacturers' Association ; British Malleable Tube Fittings Association ; Cast Iron Chair Association ; Greensand Pipe Founders Association of Scotland ; Cast Iron Heating, Boiler, and Radiator Manufacturers' Association ; Cast Iron Segment Association ; National Ingot Mould Association ; Cast Iron Axlebox Association ; Institute of British Foundrymen (affiliated) ; British Cast Iron Research Association (affiliated) ; British Grit Association (affiliated) ; Agricultural Engineers' Association (affiliated).

INSTITUTE OF BRITISH FOUNDRYMEN

PRESIDENT, 1941-42 : Major R. Miles, M.Eng. Head Wrightson & Company, Limited, Thornaby-on-Tees.

LIST OF SECRETARIES—

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